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OPTIMIZATION OF WIRE-CUT EDM PROCESS PARAMETERS FOR SS304 USING DESIGN OF EXPERIMENT

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ABSTRACT

Wire-Cut Electrical Discharge Machining (WEDM) is a non-customary machining process that included a transient start releases through the liquid because of the potential contrast between the cathode and the workpiece. The point of this venture is to decide the impact of parameters in getting better surface harshness for machining stainless steel review, SS304 workpieces utilizing Wire-Cut Electrical Discharge Machining (WEDM). Fundamentally, despicable estimations of parameters in EDM machine may come about a couple of issues like the machine may reason for poor machining execution and it will diminish the exactness of items. This paper exhibits a central report attributes of Wire-Cut Electrical Discharge Machining (WEDM) ie, surface roughness(Ra) and material expulsion rate (MRR) by utilizing L9 orthogonal cluster in order to advance the comprehension of the WEDM process. Wire-Cut Electrical Discharge Machining (WEDM). In order to get better precision incomes about, a broad writing overview had been improved the situation making the copy of the exploratory setup.

KEYWORDS: WEDM, Taguchi's L9 Orthogonal Array, Surface Roughness & Taguchi Optimization Method

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Original Article

INTRODUCTION

Wire-Cut Electrical Discharge Machining (WEDM) is currently turned into the most critical acknowledged advancements in assembling businesses since numerous unpredictable 3D shapes can be machined utilizing a basic formed instrument terminal.[1] Wire-cut Electrical Discharge Machining (WEDM) uses a persistently voyaging wire anode made of thin copper wire distance across 0.05-0.3 mm, which is equipped for accomplishing little corner radii. Copper was the first material initially utilized as a part of WEDM. Despite the fact that its conductivity rating is incredible, its low rigidity, high dissolving point, and low vapor weight rating seriously restricted its potential. Stainless Steel (SS304) is utilized as a workpiece.[2] Stainless Steel 304 is a nickel and chromium based compound, which is broadly utilized as a part of valves, refrigeration hardware, evaporators, cryogenic vessels because of their excellent consumption safe, high malleability, non-attractive and it holds strong stage up to 1400^{o}C. Chemical Composition of the work material has appeared in table 1

Table 1: Chemical Composition of Stainless Steel (SS304)

Chemical Composition(%)	Carbon C	Chromium Cr	Nickel Ni	Magnesium Mn	Phosphorous P	Sulphur S	Silicon Si
SS304	0.08	18.26	8.42	1.86	0.026	0.016	0.41
Range	Upto 0.08	18.00 - 20.00	8.00 - 10.50	upto2.00	upto0.045	upto0.030	upto0.75

In the machining, there are a couple of attributes which impact the machining procedure. Most critical are Pulse on time (Ton) and Material Removal Rate (MRR). These attributes ought to be considered when great machining execution is required[4].

The goal of this venture is to break down the impact of different machining parameters in getting surface harshness as low as would be prudent and to decide the Material Removal Rate (MRR). To accomplish this present, Taguchi's Optimization Method is utilized. Nine trials are made among which the trial with nearly low surface unpleasantness esteem will be chosen as most appropriate parameters esteem for smooth surface finish[1].

DESIGN OF EXPERIMENT

Taguchi strategy is connected to design the analysis. orthogonal clusters were presented in the 1940s and have been broadly utilized as a part of planning tests.[6] it is utilized to decrease the quantity of trials should have been performed than the full factorial trial. in view of the wire anode and workpiece capacity, the procedure parameters and the level of the procedure parameters were chosen and recorded in table 2

Table 2: Machining Parameters and Their Levels

S. No.	Process Parameters	Unit	Level 1	Level 2	Level 3
1	Pulse on time	µs	120	123	125
2	Pulse off time	µs	50	52	55
3	Servo Voltage	Volts	15	20	25
4	Peak Current	Amps	210	220	230

Taguchi proposed to obtain the trademark information by utilizing orthogonal clusters and to dissect the execution measure from the information to choose the ideal procedure parameters. The composed blend of info parameters and its relating surface harshness has appeared in table 3

Table 3: L9 Orthogonal Array for Machining

S. No.	Process Parameters			
	Pulse on time (µs)	Pulse off time (µs)	Servo Voltage (V)	Peak Current (A)
1	120	50	15	210
2	120	52	20	220
3	120	55	25	230
4	123	50	20	230
5	123	52	25	210
6	123	55	15	220
7	125	50	25	220
8	125	52	15	230
9	125	55	20	210

RESULTS AND DISSCUSSIONS

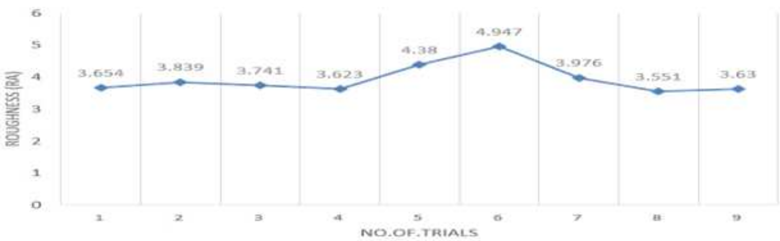
Roughness plays an important role in determining how a real object will interact with its environment. Rough surfaces more often than not wear more rapidly and have higher rubbing coefficients than smooth surfaces (see tribology). Harshness is regularly a decent indicator of the execution of a mechanical segment, since anomalies in the surface may frame nucleation destinations for splits or erosion... On the other hand, roughness may promote adhesion.

In spite of the fact that a high unpleasantness esteem is regularly unfortunate, it can be troublesome and costly to control in assembling. Diminishing the unpleasantness of a surface will more often than not expand its assembling costs. This regularly brings about an exchange off between the assembling expense of a part and its execution in the application.

EXPERIMENTAL RESULTS

Table 4: Experimental Results

S. No.	Process Parameters				Surface
	Pulse on time	Pulse off time	Servo	Peak	
	(µs)	(µs)	Voltage (V)	Current (A)	(µm)
1	120	50	15	210	3.654
2	120	52	20	220	3.839
3	120	55	25	230	3.741
4	123	50	20	230	3.623
5	123	52	25	210	4.380
6	123	55	15	220	4.947
7	125	50	25	220	3.976
8	125	52	15	230	3.551
9	125	55	20	210	3.630



Graph 1: Roughness (Ra) Vs No. of. Trials

MATERIAL REMOVAL RATE (MRR)

MRR = (MRW/T) in **Kg/min**

MRW = Material removal weight

T = Machining time

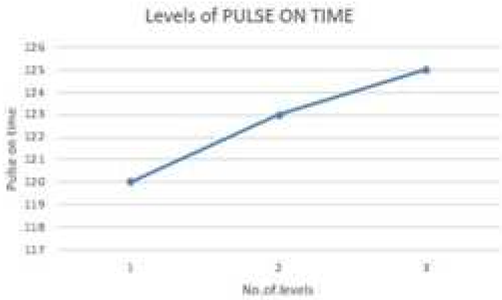
Model Calculation

MRR = (0.0058/30)0.019×10^{-2} Kg/min

Table 5: Material Removal Rate (MRR)

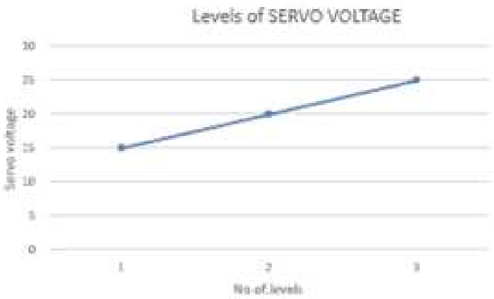
S. NO.	MRW (Kg)	Machining Time (min)	MRR (Kg/min)
1	0.0058	30	0.019×10-2
2	0.0105	30	0.035×10-2
3	0.0154	30	0.051×10-2
4	0.0100	30	0.033×10-2
5	0.0151	30	0.050×10-2
6	0.0198	30	0.066×10-2
7	0.0052	30	0.017×10-2
8	0.0099	30	0.033×10-2
9	0.0157	30	0.052×10-2

3.2. ANALYSIS OF SURFACE ROUGHNESS (Ra)



Graph 2: Effect of a pulse on time

Graph 3: Effect of Pulse off time

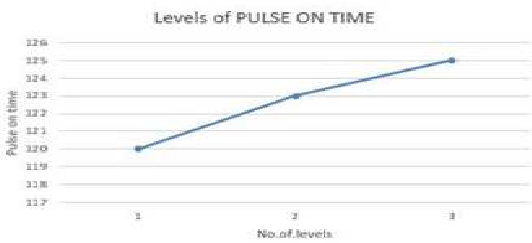


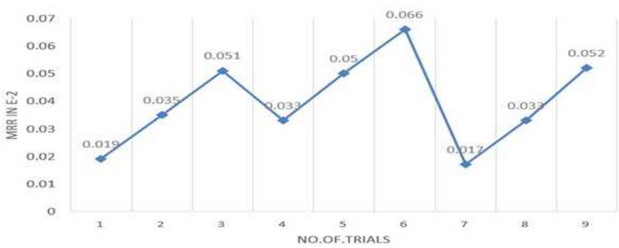
Graph 4: Effect of Servo Voltage

Graph 5: Effect of Peak Current

ANALYSIS OF MATERIAL REMOVAL RATE (MRR)

There is numerous factor should be considered amid working the machine to ensure the outcomes create are in great condition and increment profitability. The most vital factor in influencing the creation to run speedier is the time taken for machining item. The time taken for machining can be express in term of material expulsion rate (MRR). Material evacuation rate (MRR) is an estimation of time that ascertained to decide the rate of creation in businesses.





Graph 6: MRR vs No. of. Trials

DISCUSSIONS

The primary impact plots of SR have appeared in Figure 3. This figure demonstrates that release current has the most imperative impact when contrasted with different elements, on the grounds that higher pulse current makes more vitality be discharged for softening prompting the development of breaks and consequently coming about a poor surface finish. At the point when the pulse on time is expanding SR increments up to the greatest level then it begins to diminish somewhat. As the pulse on-time builds, the aggregate vitality provided to the workpiece is all the more, so more material is disintegrated from the surface of workpiece bringing about increment of SR. In any case, with the high pulse on time, the plasma framed between the entomb terminal hole impedes vitality exchange consequently little cavities are shaped, so SR lessens. pulse off time and servo encourage framework isn't fundamentally influenced the surface finish.

MRR expanded with Ton from 110 µs to 118 µs. As the beat on time expands, the aggregate vitality supply to the workpiece is all the more, so more material is disintegrated from a workpiece. The investigation of changes Table 5 shows the Ip is fundamentally influenced and different components haven't influenced the SR. Table 6 demonstrated the reaction table for SR as per this table Ip is more critical than Ton, Toff and SF vital separately.

CONCLUSIONS

This test examined the impacts of machining parameters on Wire-cut Electric Discharge Machining (WEDM) process utilizing Taguchi's advancement technique. As a conclusion, the tests of this paper presume that the machining parameters in machining procedure of Wire-cut Electrical Discharge Machining (WEDM) impact the machining execution. Trial examination on wire electrical release machining of Stainless Steel (SS304) has been finished utilizing copper wire of 0.25mm. The accompanying conclusions are made. In light of Taguchi's improvement strategy, the streamlined information parameter mixes to get the base surface unpleasantness are 15 V servo voltage, 125 µs beat on time, 52 µs beat off time and 230 A pinnacle current. The higher material expulsion rate (MRR) will bring about better machining execution rate. In this investigation, the higher material expulsion rate (MRR) is gotten at 123 µs beat on time, 55 µs beat off time, 15 V servo voltage and 220 A pinnacle current. The destinations, for example, surface harshness and material expulsion rate are advanced utilizing a taguchi orthogonal cluster technique and the same has been approved with the trial comes about.

Nomenclature

Technical Terms	Units	Abbreviation
GV - Gap voltage (V) WF - Wire feed (mm/min) TON - Pulse on time (µs) TOFF - Pulse off time (µs) Ra - Surface Roughness Kf - Kerf Width %P - Percentage Contribution	V - Volts mm - Millimetre min - Minute µs - Micro Seconds µm - Micro meter	WEDM wire cut electrical discharge machining DOF degrees of freedom LB lower the better SS stainless steel

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